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**RECOMMENDATIONS FOR THE DIRECT  
ESTABLISHMENT OF VEGETATION ON TRIAL  
AREAS OF WASTE ROCK, HIGH WALL AND  
ROAD-CUT SLOPES IN THE VICINITY OF  
BARNEYS CANYON MINE AND BARNEYS  
CANYON SOUTH AND THE MELCO PIT,  
RESPECTIVELY**

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## 1.0 INTRODUCTION

The feasibility of establishing vegetation cover directly into waste rock, without topsoil cover, is being investigated at the Barneys Canyon Pit. The study relates to vegetation establishment on more or less horizontal surfaces. Consequently, the work will not yield data on the effects of slope aspect and inclination on vegetation performance. Therefore, the feasibility of establishing vegetation directly into angle of repose waste rock, and of attaining acceptable cover on harsh, southern aspects, remains uncertain.

This document summarizes recommendations to investigate the performance of a standard mixture of plant species and topsoil cover on waste rock slopes of differing angle and aspect. In so doing, it is anticipated that the feasibility of establishing acceptable vegetation cover directly into angle of repose waste rock will be determined, as well as the erodibility of topsoil cover on waste rock.

Vegetative reclamation of open pit highwalls is also of concern, due to the limitations of vegetation establishment on rock faces. However, a number of quarry reclamation programs have demonstrated the value of establishing pockets of vegetation in growth media which can be sprayed as an hydraulic slurry onto fractured rock faces. In most cases, combinations of organic materials have proven to be useful soil substitutes which have promoted plant growth in rock crevices and on ledges. It is proposed that this approach, using laterally-spreading grass species, is investigated on the highwall of the Barneys Canyon South Pit, as well as road cut slopes at the 7300 dump. Methods of transplanting trees into amended pockets of rock would also be investigated at the Barneys Canyon South Pit.

This document presents a summary of the methods recommended for inclusion in the aforementioned studies. Schedules of site operations and costs are included. It is assumed that hydraulic seeding will be undertaken by external contractors, for a fixed unit cost, and that surface preparations and tree transplants will be performed by Barneys Canyon Mine.

## 2.0 METHOD

### 2.1 Vegetation Establishment on Waste Rock Slopes

It is proposed that field trials to determine the effect of slope angle and aspect, and topsoil cover, on the growth performance of a standard mixture of plant species is investigated. Additionally, the effect of slope angle on topsoil erosion should be assessed.



The north and south facing slopes of the 6400-6500 west waste rock dump are appropriate for this work. The experimental design involves the construction of an 8 block trial area, comprising:

- surfaces with and without topsoil, on
- north and south facing aspects, at
- angle of repose slopes and regraded slopes at 2.0:1.

The conceptual layout of this trial is shown on Figure 1.

The four blocks on both north and south facing slopes should be approximately  $\frac{1}{8}$  acre surface area each, demarcated and labelled appropriately. It is recommended that slope regrading and surface preparation are completed in time for fall seeding, in late September/early October.

### Surface Preparation

The surface of each block should be scarified laterally, when slope regrading on the 2.0:1 blocks has been completed. Scarification can be achieved by ripping the surface horizontally at 6 inches to 12 inches depth, with 12 inch spaces between blades. If this is not practically possible, the final, topsoiled surface should remain rough and uncompacted.

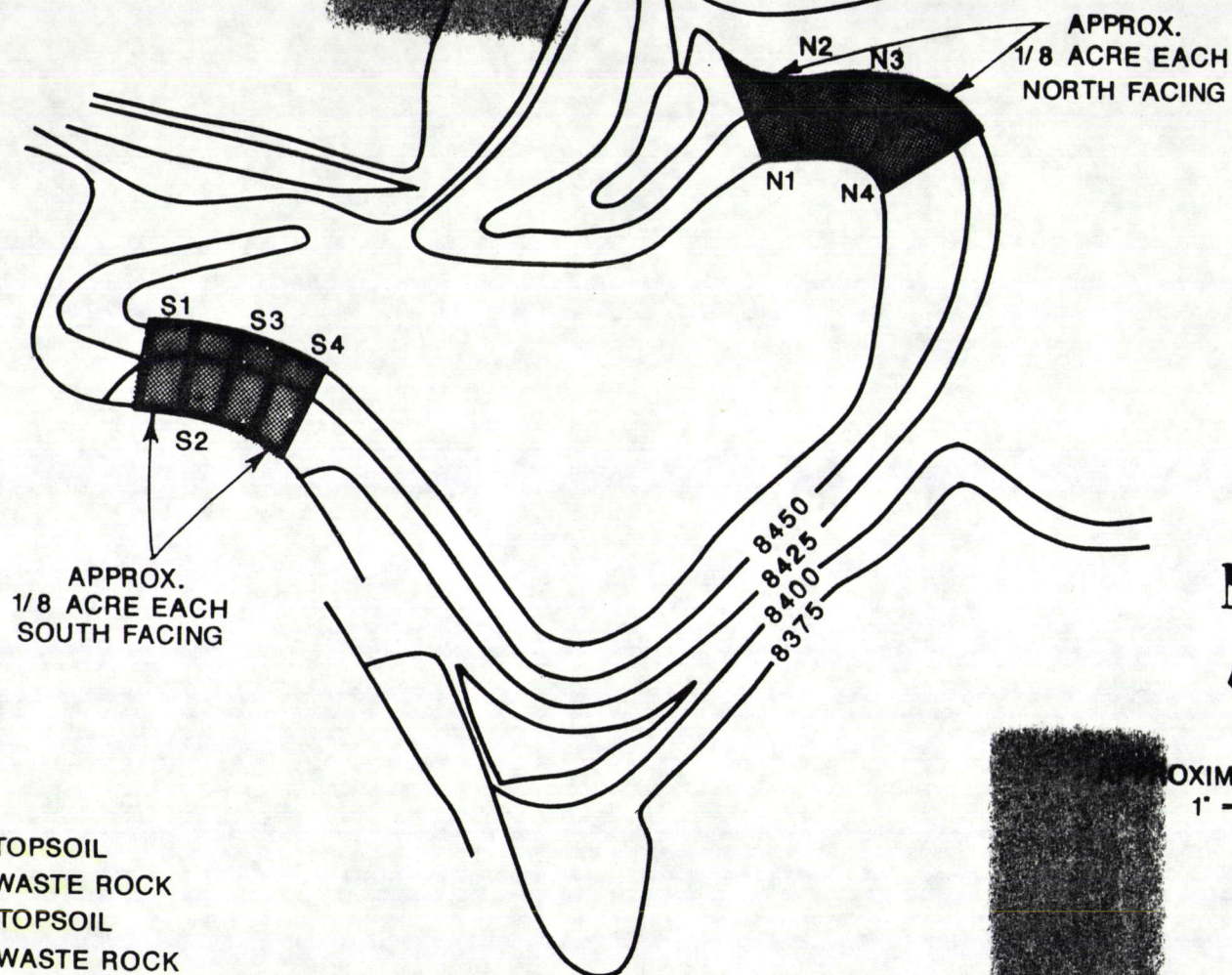
In accordance with procedures set out in NOI 1989, as amended 1992, selected blocks will be topsoiled with approximately 12 inches of topsoil.

Ideally, alfalfa mulch should be worked into the surface at this stage, and ideally left for a 2 month period before seeding. The recommended application rate is 4000lb/acre. If this is not practically possible, then mulch, seed and fertilizer may be applied simultaneously with an hydraulic seeder in the fall.

### Fertilization

On the basis of results recorded to-date, from field trials performed at the Barneys Canyon Pit, the use of a compound 18-46-0 fertilizer is appropriate. An application rate of 310lb/acre is recommended on the assumption that the chemical and physical properties of the waste rock and topsoil are similar to those at the existing Barneys Canyon Pit trial.





N4/S4 : 2.0:1 / TOPSOIL  
 N3/S3 : 2.0:1 / WASTE ROCK  
 N2/S2 : 1.5:1 / TOPSOIL  
 N1/S1 : 1.5:1 / WASTE ROCK

PROJECT NO. 29505	PREPARED BY: 	<b>FIGURE 1</b>  <b>6400-6500 WEST WASTE ROCK DUMP TEST PLOTS</b>
DATE 7/93	<b>STEFFEN ROBERTSON &amp; KIRSTEN (U.S.)</b> Consulting Engineers & Scientists	
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## Species Mixture

The mixture of grass and forb species used at the Barneys Canyon Pit trial is also suitable for experimental work at the 6400/6500 waste dump. The required species, and their application rates when hydraulically seeded, are shown in Table 1.

<b>TABLE 1</b> <b>SPECIES OF GRASSES AND FORBS SELECTED FOR RECLAMATION TRIALS</b> <b>AT DUMP 6400/6500</b>				
<b>Botanical Name</b>	<b>Variety</b>	<b>Common Name</b>	<b>Growth Habit</b>	<b>Application Rate lb/acre</b>
<i>Agropyron smithii</i>	Boston/ Rosanna	Western wheatgrass	Perennial/ sod forming	10
<i>Agropyron spicatum</i>	Secar	Bluebunch wheatgrass	Perennial/ bunch	8
<i>Festuca ovina</i>	Covar	Sheeps fescue	Perennial/ bunch	4
<i>Elymus elymoides</i>		Squirrel tail	Perennial/ bunch	5
<i>Poa canbyi</i>	Canbar	Canby bluegrass	Perennial/ bunch	2
<i>Secale cereale*</i>		Cereal rye	Annual/ nurse	8
<i>Astragalus cicer</i>	Lutana	Cicer milkvetch	Perennial/ rhizomes	6
<i>Melilotus officinalis*</i>	Yukon	Yellow sweet clover	Short-lived biennial	2
<i>Medicago sativa</i>	Vernal	Alfalfa	Perennial/ deep-rooted	4
<i>Penstemon palmeri</i>	Cedar	Palmer penstemon	Perennial/ sod forming	2
* Temporary "nurse" cover.				



## Erosion Protection

Given the slope angles upon which vegetation is to be established, silver fiber mulch and a plantago gum tackifier will be used to stabilize the soil surface. Because of the hydraulic seeder pumping limit of 4% suspended solids, it is necessary to hydromulch the seeded area with fiber mulch and tackifier as a separate application, immediately following seeding. Recommended application rates are:

- Silver fiber - 2000lb/acre
- Plantago gum - 100lb/acre

## Operations Summary:

### July 1993

Block demarcation and identification  
Surface regrading  
Scarification/ripping at 12 inches  
Topsoiling/ripping  
Alfalfa mulch incorporation @ 4000lb/acre

### September/October 1993

Hydraulic seeding with:

- compound 18-46-0 @ 310lb/acre
- seed mixture @ 51lb/acre

Hydromulching with:

- silver fiber mulch @ 2000lb/acre
- plantago gum @ 100lb/acre

## **2.2 Vegetation Establishment at the Barneys Canyon South Pit**

The strategy for reclaiming rock faces at the Barneys Canyon South Pit includes the transplantation of oak saplings into amended pockets situated along horizontal benches, and hydraulic seeding of the highwall, to promote vegetation establishment on benches, ledges and in crevices. In order to accelerate vegetation establishment, it is recommended that the rock faces are treated with hydraulic applications of tertiary treated sludge and silver fiber mulch at higher than usual application rates.



If available, and at an acceptable cost, the mulch/organic sludge mixture should be supplemented with vermiculite. The following minimum rates are recommended:

- Sludge @ 4000lb/acre
- Mulch @ 4000lb/acre
- Vermiculite @ 2000lb/acre

If vermiculite is locally unavailable, sludge and mulch application rates should be increased by 1000lb/acre each. It is likely that these unusually high rates will require several applications if a standard hydraulic seeder is used.

If practically possible, tipping topsoil onto ledges and benches would be useful for vegetation establishment on horizontal surfaces of significant surface area.

This artificial seed bed will require several weeks of consolidation under relatively dry weather conditions, before hydraulic seeding can proceed. Fertilization, seeding and stabilization may be performed simultaneously, as follows:

#### **Fertilization**

Compound 18-46-0 fertilizer applied at a rate of 350lb/acre is appropriate for this purpose.

#### **Seed Mixture**

A mixture of grass and forb species recommended for rock slope rehabilitation is described in Table 2. The mixture is designed to provide rapid initial growth from the temporary annual wheat x wheatgrass hybrid, Regreen. This annual will also provide an extra layer of organic material on ledges, at the end of the season. Perennial growth will be achieved by using a combination of small-seeded grasses and forbs which have a tendency for lateral, vegetative growth or clumping. Long-term growth is provided by mountain mahogany which, although very slow to establish, is associated with long-term growth on rocky faces.



**TABLE 2  
SPECIES LIST**

LATIN NAME	COMMON NAME	ORIGIN	HABIT	VARIETY	RATE (lb/acre)
<b><u>GRASSES:</u></b>					
• <i>Secale x Agropyron Hybrid</i>	Regreen Wheatgrass	IxN	Sod	Regreen	5
• <i>Agropyron intermedium</i>	Intermediate Wheatgrass	I	Bunch/Sod	OAHE	10
• <i>Agropyron riparium (sodar)</i>	Streambank Wheatgrass	N	Sod	Sodar	10
• <i>Oryzopsis hymenoides</i>	Indian Ricegrass	N	Bunch	Nezpar	5
• <i>Festuca ovina</i>	Sheep Fescue	N	Bunch	Covar or Common	5
<b><u>FORBS:</u></b>					
• <i>Astragalus cicer</i>	Cicer Milkvetch	I	Forb	Monarch	6
• <i>Achillea lanulosa</i>	Western Yarrow	N	Forb	Common	2.5
• <i>Lupinus alpestris</i>	Mountain Lupine	N	Forb	Common	2.5
<b><u>SHRUBS:</u></b>					
• <i>Cercocarpus ledifolius</i>	Curleaf Mountain - Mohagany	N	Shrub	Montaine	2
• <i>Rosa woodsii</i>	Woods Rose	N	Shrub	Common	2

### Erosion Protection

Further seed protection and organic substrate stabilization can be achieved by concurrent hydromulching, using silver fiber mulch and plantago gum adhesive. It is necessary to apply fertilizer, mulch and seeds simultaneously in this case, to prevent seed dislodgement and wash-off by the hydromulch slurry. Recommended application rates are:

- Silver fiber mulch @ 2000lb/acre
- Plantago gum @ 200lb/acre



### Forest and shelter belt planting

Trees planted 1.5 x 1.5 m centres on ploughed ridges, notch planted and firmed up again in late spring. 50 gm of S.A.I. Enmag fertilizer applied around each tree

Single (or double) furrow ploughing at 1.5 m centres during summer before planting season



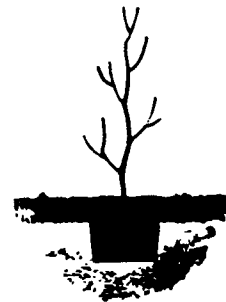
Trees kept free of competing vegetation by annual chemical weeding using approved herbicides

### Whips

These slightly larger and more sturdy plants are mainly used for small planting areas where ploughing before planting may not be possible or where a plant sturdy enough to withstand some competition is required.

Whips are normally used, often with feathered whips, to form small spinneys in irregularly shaped areas of land where some early landscape effect is required. Owing to their larger size and the need to give them a good start and keep them free from competition, whips are normally pit-planted.

The sort of planting specification for whips is outlined on right:



**Whip Planting**  
Pit dug approx 25 cm x 25 cm x 25 cm bottom 150 mm loosened. 50 gm of S.A.I. Enmag with topsoil backfill.

### Feathered whips

These are a most useful range of planting stocks, varying as they do from 0.9-2.4m in height and fully furnished with side branches. Because of this they are more stable than similar sized standards and can be used with considerable effect for low screening or shelter if mass planted at relatively close spacings of 1.5-1.8m centres.

They are ideal for planting small areas to create spinneys and for narrow screening or sheltering belts where some early effect is required.

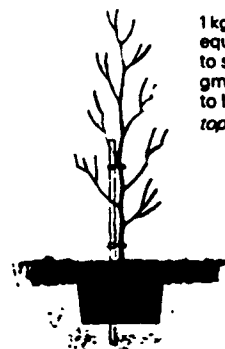
Staking is normally required to get them established, but they do not need such substantial stakes or ties as standard trees particularly if mass planted.

Feathered whips are frequently used in conjunction with ordinary whips and with larger standards to give some body to the finished planting.

These are also ideal for planting as hedgerow trees by virtue of their substance and stability, also some favourite hedgerow species such as Oak and Field Maple are difficult to obtain as standards, but are more readily available as feathered whips around 1.2-1.8m in height.

A typical specification for planting feathered whips is given on right:

### Planting Feathered Whips & Shrubs



1 kg - 3 kg of peat or equivalent, according to size and 50 - 200 gm of S.A.I. Enmag, to be mixed with topsoil backfill.



1 kg peat or equivalent & 50 gm of S.A.I. Enmag to be mixed with topsoil backfill.

A temporary tree stake with tree ties for early support may be needed until established.

Excavate pits 15 cm wider than root spread and to a depth of 30 cm, fork over bottom 15 cm of pit.

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## FIGURE 2

### GUIDE LINES FOR TREE ESTABLISHMENT



It is recommended that a portion of the highwall rock face, covering an area of about 0.5 acre is used to test the feasibility of this approach.

### **Tree Transplants**

It is proposed that the feasibility of establishing trees in appropriately amended pockets of rock, situated along horizontal benches, is also investigated at the Barneys Canyon South Pit. Ideally, individuals of 3 feet minimum height should be transplanted in early spring.

Transplantation should be into pockets of rock, amended with local topsoil. The topsoil may be supplemented with up to 50% waste rock/overburden, such as that located on the 6400/6500 dump. Methods of establishing forest transplants into pockets are summarized in Figure 2. A more detailed specification for transplanting and fertilizing will be provided well in advance of the Spring of 1994 season.

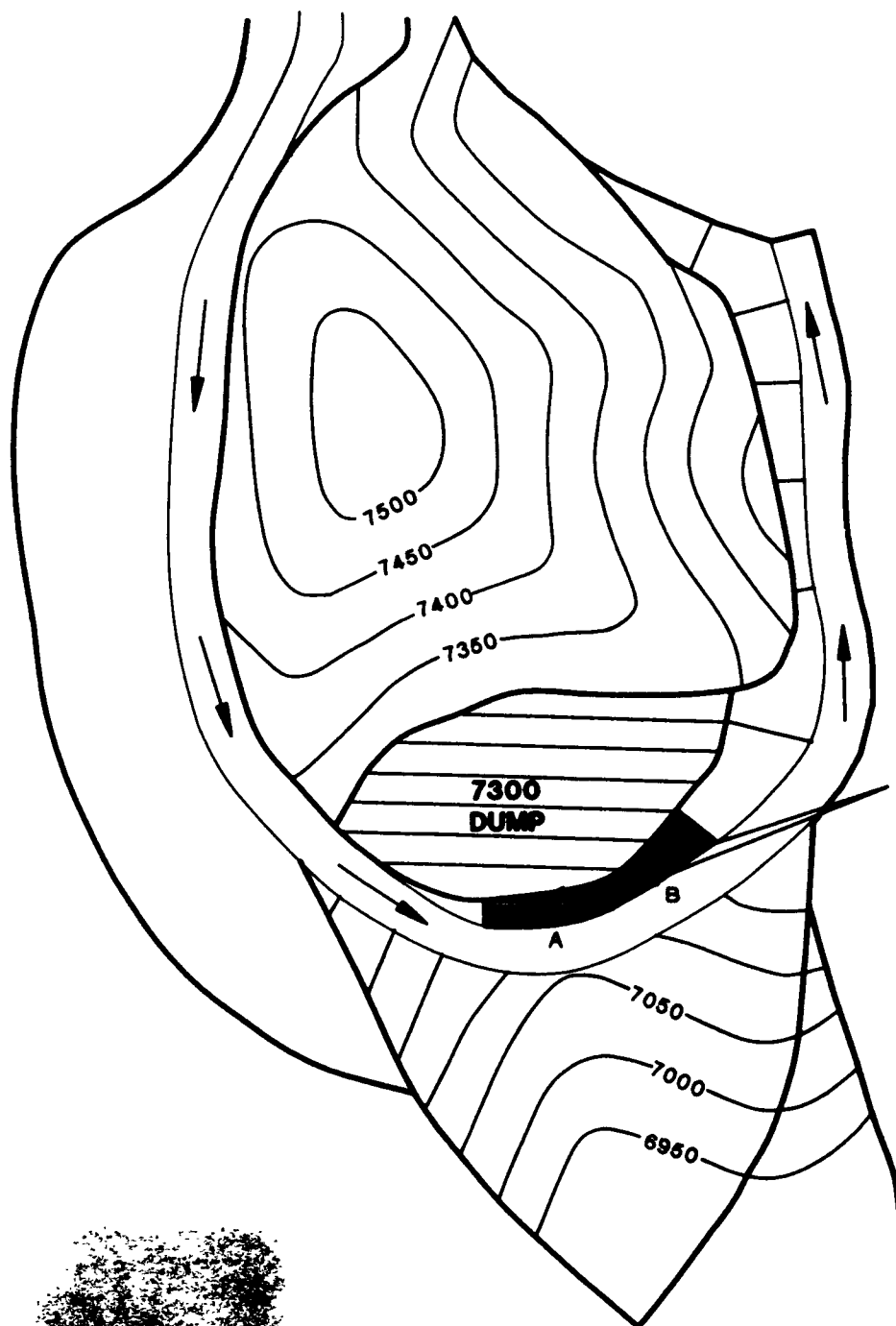
### **2.3 Vegetation Establishment on Cut Slopes: 7300 Dump**

The road cut slopes at this location provide a significant obstacle to vegetation establishment, as a consequence of steep slope angles and predominantly bare rock faces. If vegetation is to be established on these slopes, the surfaces should be horizontally and deeply scarified, to provide microhabitats for root development. Slope angles greater than 1.5:1 are assumed to be intractable problems for plant establishment.

It is proposed that a comparison of the two methods is undertaken. An area of approximately 0.5 acre on a dry, south facing slope will be required. The 0.5 acre plot should be split into two equal blocks. One block will be treated with the mixture applied to the wall of the South Barneys Canyon South Pit. This is summarized as:

- Sludge @ 4000lb/acre
- Silver fiber mulch @ 4000lb/acre
- Vermiculite @ 2000lb/acre
- Compound 18-46-0 @ 350lb/acre
- Seed mixture @ 50lb/acre
- Plantago gum @ 200lb/acre





APPROX  
1/4 ACRE EACH  
FACING SOUTH

A: CELLULOSE/ ORGANIC MULCH  
B: CONVEX GREEN NETTING

APPROXIMATE SCALE  
1" = 300'

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**FIGURE 3**

**7300 DUMP/ ROAD CUT  
TEST PLOTS**

The technique with which this method will be compared requires the second 0.25 acre block to be hydroseeded with Conwed netting finally placed over the treated surface. The use of Conwed, a proprietary biodegradable plastic net, allows lower mulching rates to be applied, with enhanced surface stability and moisture retention. The following treatments will be necessary:

- Seed mixture @ 50lb/acre.
- Compound 18-46-0 @ 350lb/acre.
- Straw mulch @ 4000lb/acre.
- Conwed Netting.

The proposed location of this trial is shown on Figure 3.

### 3.0 SCHEDULE

With the exception of tree transplantation at Barneys Canyon South, all surface preparations should be completed in time for fall hydroseeding in late September/early October. However, it is recommended that tree saplings of about 3 ft height are identified and removed from their current locations, for containerization and acclimation over the winter months. Tree specimens should not be disturbed until the end of the growing season, in late September.

Each trial area should be monitored throughout the 1994 growing season, at least. Monitoring over two growing seasons is preferable.

The proposed schedule of activities for each trial area is summarized in Table 3.

### 4.0 COSTS

A unit cost of \$900/acre for hydraulic seeding, using external contractors, has been assumed. Costs of earthmoving and surface preparation have not been included in this estimate; nor have those related to tree transplantation and vegetation establishment on the unfinished waste rock slopes, facing Bingham Canyon. Specifications and costs related to tree transplants will be provided separately before Spring, 1994.

Table 4 itemizes professional and disbursement costs required to construct and monitor trials over the following areas;

- 6400/6500 Waste Rock Dump: 1 acre



- Barneys Canyon South: 0.5 acre
- Melco Haul Road: 0.5 acre

Over two growing seasons, the professional costs amount to \$11,315.00, with reimbursable disbursement costs, including hydraulic seeding, totaling \$5,887.00.





**TABLE 4**  
**MONTHLY PROFESSIONAL AND DISBURSEMENT COSTS**

ACTIVITIES	JUL - '93	AUG	SEPT	OCT	JUN - 94	JUL	AUG	SEPT
<b><u>PROFESSIONAL COSTS:</u></b>								
• Final Specifications & Site Instructions	\$1,840							
• Monitoring/Site Visits				\$1,150	\$1,200		\$1,200	\$1,200
• Standards Review							\$960	
• Report and Recommendation								\$1,200
• Project Management	\$345	\$345		\$345	\$360		\$360	\$360
• Secretarial/Administrative								\$450
<b>TOTAL PROFESSIONAL COSTS:</b>	<b>\$2,185</b>	<b>\$345</b>	<b>0</b>	<b>\$1,495</b>	<b>\$1,560</b>	<b>0</b>	<b>\$2,520</b>	<b>\$3,210</b>
<b><u>DISBURSEMENTS:</u></b>								
• Air Travel				\$465	\$480		\$480	\$480
• Ground Transportation				\$45	\$50		\$50	\$50
• Accommodation				\$75	\$80		\$80	\$80
• Printing & Copying								\$50
• External Services (hydroseeding)				\$2000				
• Conwed Netting				\$750				
• Computing and Communications	\$125	\$35		\$92	\$96		\$144	\$180
<b>TOTAL DISBURSEMENTS:</b>	<b>\$125</b>	<b>\$35</b>	<b>0</b>	<b>\$3,427</b>	<b>\$706</b>	<b>0</b>	<b>\$754</b>	<b>\$840</b>
<b>MONTHLY TOTALS:</b>	<b>\$2,310</b>	<b>\$380</b>	<b>0</b>	<b>\$4,922</b>	<b>\$2,266</b>	<b>0</b>	<b>\$3,274</b>	<b>\$4,050</b>